

The Absolute SIM reference frame and its Relationship to the International Celestial Reference Frame

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1. Introduction

SIM PlanetQuest (SIM) will be capable of defining a celestial reference frame to orders of magnitude greater accuracy than the present International Celestial Reference Frame (ICRF) defined by the radio positions of extragalactic radio sources (Ma et al. 1998).

SIM's operating bandwidth will be 0.4 to 1.0 micron, thus defining a frame at optical/near IR wavelengths. The SIM frame will be related to the present ICRF through SIM observations of a subset of the objects defining the present ICRF. In this document we estimate the accuracy of the SIM reference frame and discuss its relationship to the present ICRF.

2. The SIM Project Level Requirements Appendix (PLRA):

The SIM PLRA states that the Overall System Requirements for SIM are:

“The SIM will be capable of establishing to 4 μ as accuracy, an absolute stellar reference frame that can be used for a variety of astrophysical investigations.”

“The SIM will be capable of determining positions, parallaxes, and proper motions to 4 μ as and 4 μ as/yr accuracy for 4000 stars, some as faint as magnitude V=20.”

“The SIM will be capable of determining positions, parallaxes, and proper motions to 20 μ as and 20 μ as/yr accuracy for 20,000 stars, some as faint as magnitude V=16.“

The SIM reference frame will be based on the positions of 1304 reference grid stars globally distributed among 15 degree tiles on the sky. The positions of these grid stars will be determined relative to one another to an individual accuracy of <4 μ as in position and parallax and <4 μ as/yr in proper motion. This will be accomplished by observations of K0III reference stars of visual magnitude 10-12. Individual observations will be made to an accuracy of 10 μ as. Observations obtained over the 5-year mission lifetime will give the stated mission accuracies.

3. Defining an absolute frame

The grid stars together with other stars and extragalactic sources observed by SIM will define a reference frame. The orientation of this frame depends on the knowledge of the positions and motions of the objects making up the frame. For example, lack of precise knowledge of the proper motions will lead to changes in the orientation of the frame with time. In order to remove any residual rotation in the SIM stellar reference frame i.e. to make the frame quasi-inertial, and enable determination of absolute proper motions, a

number of extragalactic sources must be observed with SIM. These distant sources are assumed to have negligible proper motions. In order to remove the rotation in the SIM stellar frame, we need to determine three angular velocity coordinates. In theory, only two fixed extragalactic objects (3 coordinates total) could be used to determine the rotation of the SIM stellar frame defined by the grid stars. In practice, the structure and variability of the reference sources error propagation in the grid solution and possible zonal systematic errors dictate that a global distribution of extragalactic sources be used.

The ICRF consists of 212 extragalactic radio sources that vary in magnitude from 13 through >20 visual magnitudes. Their radio emission displays compact structure on size scales of order less than a milliarcsecond. Observations of objects fainter than 16th visual magnitude with SIM will be difficult, as they will take an excessive amount of observing time. Observations of the optically brightest compact extragalactic sources are proposed here to determine/stop the SIM frame rotation. These sources may or may not have radio emission. They should be brighter than \sim 16th visual magnitude in order to insure that a large number of sources can be used to address calibration issues regarding possible source variability and structure. This is especially true since we do not know the structure of the optical emission of the extragalactic sources on size scales < 1 arc second or the variability of their emission.

We have chosen from the Veron catalog, a large number of extragalactic sources brighter than 16.5 visual magnitude supplemented by some fainter sources near the galactic plane, which have no noticeable structure on the Palomar plates. Table I lists these sources. There are 104 objects brighter than 16th magnitude, with about 50 of these brighter than 15.1 magnitude. Assuming a distribution of 100 objects with half brighter than 15th magnitude and the other 50 brighter than 16th magnitude, we can estimate the amount of observing time needed to fix the SIM stellar frame rotation. Since very little is known of the structure of the compact optical emission of extragalactic sources and their stability for μ as astrometry, it is proposed to obtain 15 and 20 μ as accurate single epoch measurements per year of the mission of 50 sources brighter than 15.1 visual magnitude and 50 sources between 15.1 and 16 visual magnitude, respectively. This can be accomplished with an integration time of 430 seconds according to testbed2 software for a K type star. These observations give sufficient margin to achieve a precision of 4 μ as/yr for the rotation of the SIM stellar frame because some of the objects may vary in position. A total of 2.1 days per year is needed for two observations of two coordinates of each of the 100 sources given 30 seconds to acquire a source. It is assumed that these measurements will be accomplished in a queue-observing mode along with the grid star observations. The time for the grid star observations is considered to be in the overhead and is not counted in the time allocated for the extragalactic source observations.

It is not known how the structure (and possible variability) of these objects will affect the SIM astrometry on the μ as level. Based on the experience with the ICRF defined by radio observations, very few sources are found to be point like and all are astrometrically unstable at some level. It is assumed that some of the objects will show astrometric signatures that indicate accelerations in position at the 15-20 μ as level and will be eliminated from the reference frame program but will make for very interesting

astrophysical studies. Our suggested approach is sensitive to variations in position and proper motion on the 7 μ as level, which allows for elimination of such sources. With the large number of sources, we consider the motion at levels $< 7\mu$ as to be random and will average out to less than 4 μ as with a sample of 50 sources. The high accuracy individual measurements of the extragalactic sources are necessary to weed out or correct those sources that have significant positional variations. Thus a high single epoch positional accuracy of the SIM observations is required to allow the detection of potentially “poor” sources for the frame rotation.

4. The relationship between the SIM frame and the ICRF

The positional accuracy of the individual sources in the ICRF catalog is of order >250 μ as at radio frequencies. Thus to align the new SIM frame to the current ICRF, observations by SIM of a significant subset of the 212 defining sources need to be performed only to a similar level of accuracy per source as in the current ICRF. SIM observations of this set of ICRF sources can easily be made to achieve ~ 100 μ as accuracy per source. A reasonable integration time at this level of precision for 10 observations (five in each coordinate) of each source is proposed spaced over the mission duration of five years. In this way, the orientation of the new SIM frame to the ICRF can be established at the accuracy of the ICRF radio observations. A revised ICRF will be established from the optical SIM observations.

5. Preliminary Studies Before the SIM Mission

5a. Source Variability

Photometric observations are underway of the sources in Table I in the Johnson B, V, I, R bands. It is planned to observe these sources annually for the next five years to ascertain their variability as well as to observe them during the year before and during the mission. Figure 2 shows the results achieved thus far for 32 sources out of the 150 observed. The V magnitudes differ significantly from Veron but the majority, 22 out of 32, is brighter than 16th magnitude. The variability in magnitudes does stress the importance of these observations. If only 2/3 of the sources brighter than 16th magnitude in Veron are brighter than 16th magnitude at the time of SIM observations, this will reduce the accuracy of the SIM frame rotation. Thus we have allowed for significant margin in the program presented earlier in section 3: over half the sources could be lost and the frame rotation could easily be estimated at 4 μ as/yr. Finally as a preliminary result that will be tested with a complete set of observations of all 242 source, it appears that these sources are redder than expected as Figure 3 shows that the sources appear to be more intense in the R band (see figure 3).

5b. Source Stability in Position

5b1. Optical

Twelve sources have been placed on the optical parallax program at Flagstaff observatory. Preliminary results show a stability of 5 mas in position even for sources

that display some structure on arc second scales at optical wavelengths. More complete observations are underway that will yield an evaluation of stability at the 1 mas level.

5b2. Radio

Observations continue at radio wavelengths to strengthen the ICRF in the southern hemisphere. Observations are also continuing of the ICRF and other radio sources to study their radio structure and establish new radio sources, which are brighter than 16th visual magnitude.

6. Plans (FY06-FY10)

Optical observations will be made of the objects given in Table 1. Frequent observation will be made of each source to ascertain the variability of these sources on timescale of days to years. It is estimated that in 2006, each source will be observed at a minimum of 3 times or more. This will be expanded in 2007 as more telescope time becomes available at Flagstaff and Cerro Tololo to as many as 25 nights/yr. This will be continued through 2008 and 2009.

Simulations will be carried out with the grid team to optimize the number and spacing of extragalactic sources for the grid solution of the stellar frame as well as the solution for the rotation of the stellar frame.

The program to do the preparatory science for radio star emission will concentrate on determining the precise positions of radio stars on the extragalactic frame. Parallaxes at a level of 10 μ as will be pursued using the VLBA. Both maser sources and radio continuum sources will be in this program.

7. Conclusions

SIM will define a celestial reference frame that will be more accurate than the ICRF. The frame defined by the SIM stellar observations can be made absolute by the observation of extragalactic sources. By using the brightest extragalactic sources, the observing time needed to stop the frame rotation to an accuracy of <4 μ as/yr is not prohibitive. However, studies of source variability must be made before and during the mission to schedule sources that are intense enough to be observed to accuracies of 15-20 μ as in a single observation. The observing sequence of the extragalactic sources must also be optimized for the grid star solution of the SIM stellar frame. These issues must be studied.

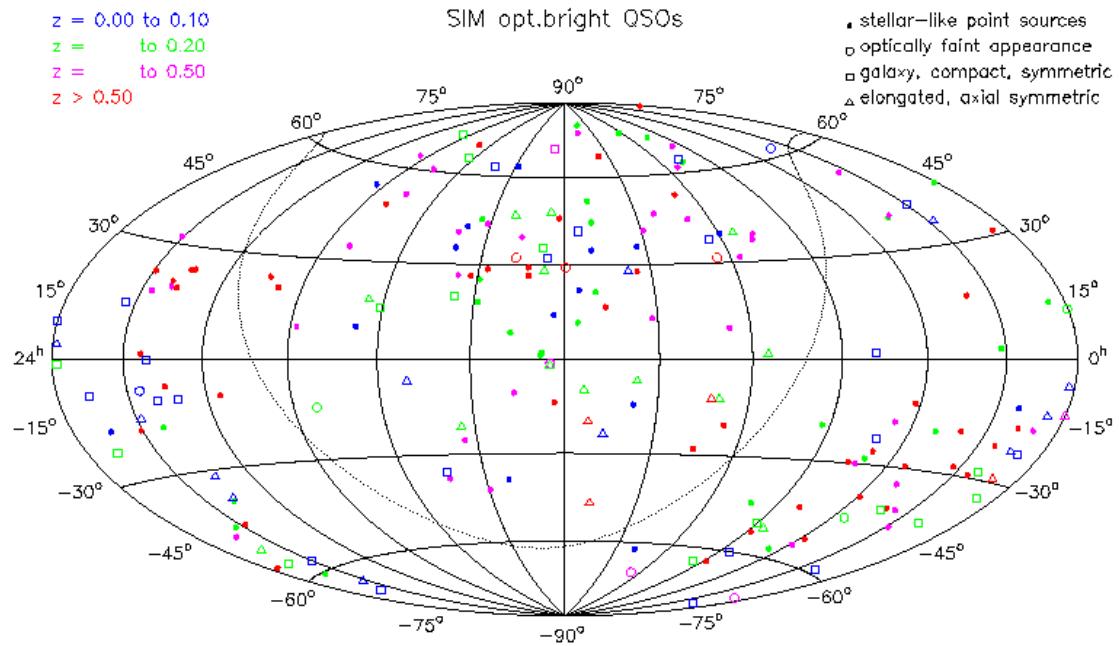
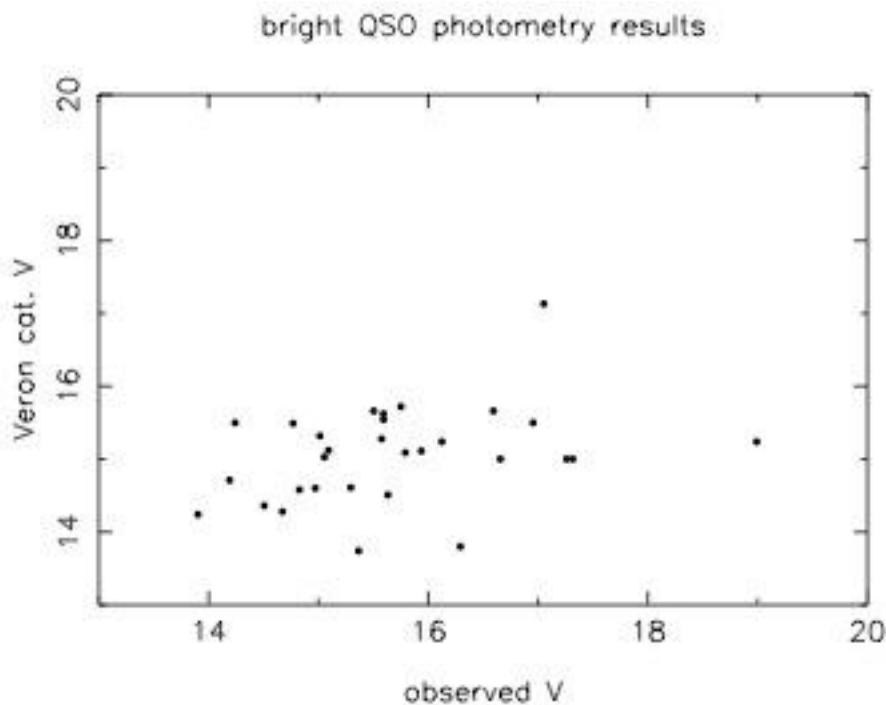


Figure1 The distribution of 242 optically bright sources being investigated for optical variability.



Fi0gure 2: The observed visual magnitude versus the reported magnitude in Veron.

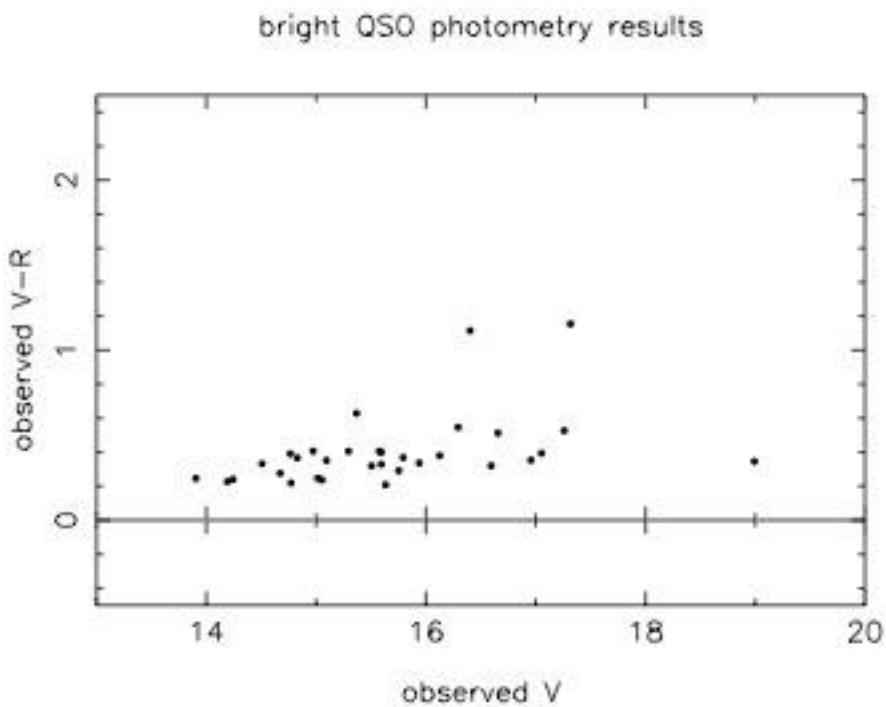


Figure 3: The observed visual magnitude versus the observed V-R magnitude. The sources appear to be redder than expected.

Table 1
Selected Bright Sources from the Veron Catalog

	Name	R.A. (J2000)	Dec. (J2000)	Radio Flux (Jy)	z	Mag. V	B-V
s	3C 273.0	12 29 6.7	2 3 8	43.41	0.158	12.85	0.2
s	CG 825	11 21 8.4	34 55 21		0.04	13.19	
s	GB6 13455+2851	13 47 51.5	28 36 30	0.092	0.741	13.5	
s	HE 1029-1401	10 31 54.4	-14 16 52		0.086	13.86	0.22
s	IRAS 04505-2958	4 52 30.1	-29 53 35		0.286	13.6	
s	IRAS 09149-6206	9 16 9.5	-62 19 29	0.016	0.057	13.55	0.52
s	IRAS 13224-3809	13 25 19.2	-38 24 54		0.065	13.8	
s	LB 1727	4 26 0.8	-57 12 1		0.104	13.2	
s	NPM1G+42.0387	14 35 49.0	42 32 21		0.072	14	
s	WENSS 0648+733	6 54 26.6	73 19 50		0.114	11.7	
s	PG 1211+143	12 14 17.7	14 3 13	0.001	0.08	14.19	0.27
s	HE 0502-2948	5 4 19.0	-29 44 39		0.552	14.2	
s	KUV 18217+6419	18 21 57.2	64 20 36	0.07	0.297	14.24	-0.01
s	PG 1351+64	13 53 15.7	63 45 46	0.032	0.087	14.28	0.26
s	RXS J02282-4057	2 28 15.2	-40 57 16		0.494	14.3	
s	MR 2251-178	22 54 5.9	-17 34 55	0.003	0.064	14.36	0.63
s	B3 0754+394	7 58 0.1	39 20 29	0.003	0.096	14.36	0.38
s	HE 0441-2826	4 43 20.7	-28 20 52	0.056	0.155	14.4	
s	RX J12308+0115	12 30 50.0	1 15 21		0.117	14.42	0.02
s	IRAS 21219-1757	21 24 41.7	-17 44 46	0.007	0.113	14.5	
s	HS 0624+6907	6 30 2.6	69 5 3		0.37	14.16	0.48
s	MS 07007+6338	7 5 29.4	63 33 33		0.152	14.51	
s	MARK 478	14 42 7.5	35 26 23	0.001	0.077	14.58	0.33
s	PG 1718+481	17 19 38.3	48 4 13	0.137	1.083	14.6	
s	HE 0246-4101	2 48 6.2	-40 48 35		0.883	14.7	
s	PG 0804+761	8 10 58.5	76 2 43	0.002	0.1	14.71	0.32
s	PG 1116+215	11 19 8.8	21 19 18	0.003	0.177	14.72	0.13
s	TON 1187	10 13 3.1	35 51 22		0.079	14.75	
s	RXS J00066+4342	0 6 36.6	43 42 29		0.166	14.8	
s	RXS J22453-4652	22 45 20.4	-46 52 12		0.201	14.8	
s	PKS 0405-12	4 7 48.5	-12 11 36	1.99	0.574	14.86	0.23
s	MS 03180-1937	3 20 21.2	-19 26 31		0.104	14.86	1.04
s	WAS 26	11 41 16.1	21 56 22		0.063	14.9	
s	HE 0515-4414	5 17 7.6	-44 10 56		1.713	14.9	
s	HE 0329-2931	3 31 14.8	-29 21 10		0.548	14.9	
s	NPM1G-12.0057	1 24 48.3	-11 58 9		0.068	14.93	
s	RXS J21127-3840	21 12 45.0	-38 40 17		0.143	14.97	
s	RXS J13564+2515	13 56 25.5	25 15 24		0.165	15	
s	RXS J16312+0955	16 31 16.0	9 55 58		0.092	15	
s	1WGA J1026.4+6746	10 26 34.0	67 46 12	0.129	1.178	15	
s	SBS 1116+518	11 19 38.1	51 33 16		0.103	15	
s	HE 0238-1904	2 40 32.6	-18 51 51		0.631	15	
s	HS 1046+8027	10 50 35.3	80 11 52		0.115	15.03	
s	PKS 0552-640	5 52 24.6	-64 2 11	0.2	0.68	15.04	
s	US 1329	8 36 58.9	44 26 2		0.249	15.09	

	Name	R.A. (J2000)	Dec. (J2000)	Radio Flux (Jy)	z	Mag_V	B-V
s	RXS J22169-4451	22 16 53.0	-44 51 57		0.136	15.1	
s	HE 0436-2614	4 38 10.2	-26 8 37		0.69	15.1	
s	CTS H34.02	5 52 0.4	-53 12 44		1.59	15.1	
s	CT 638	3 18 6.5	-34 26 37		0.265	15.1	0.1
s	PG 1114+445	11 17 6.3	44 13 34	0	0.144	15.11	
s	PG 1307+085	13 9 47.0	8 19 49	0	0.155	15.11	0.21
s	PG 1700+518	17 1 25.0	51 49 20	0.006	0.292	15.12	0.37
s	PG 1004+130	10 7 26.2	12 48 56	0.42	0.24	15.15	0.13
s	HE 0153-4520	1 55 13.2	-45 6 12		0.451	15.2	
s	APM 08279+5255	8 31 41.6	52 45 18		3.911	15.2	
s	HS 1817+5342	18 18 10.4	53 43 46		0.08	15.2	
s	PKS 1302-102	13 5 33.0	-10 33 20	0.769	0.286	15.23	-0.05
s	PG 1415+451	14 17 0.8	44 56 6	0	0.114	15.24	
s	PG 1634+706	16 34 29.0	70 31 33	0.001	1.337	15.27	
s	3C 351.0	17 4 41.5	60 44 28	1.219	0.371	15.28	0.13
s	HS 2154+2228	21 56 47.3	22 42 50		1.29	15.3	
s	Q 2200-1816	22 3 11.6	-18 1 42		*1.16	15.3	
s	PG 0953+415	9 56 52.3	41 15 23	0	0.239	15.32	-0.03
s	SDSS J21000-0711	21 0 1.3	-7 11 35		0.599	15.35	
s	IRAS 22419-6049	22 45 11.4	-60 33 55		0.113	15.4	
s	MARK 586	2 7 49.8	2 42 55	0.002	0.155	15.41	0.26
s	PG 0026+12	0 29 13.8	13 16 5	0.002	0.145	15.41	0.29
s	RXS J00281+3103	0 28 10.7	31 3 46	0.088	0.5	15.42	0.37
s	PG 1444+407	14 46 46.0	40 35 6	0	0.267	15.45	
s	B2 1721+34	17 23 20.8	34 17 59	0.493	0.206	15.46	0.12
s	KUV 12491+2932	12 51 28.8	29 15 26		1.16	15.49	
s	B2 0709+37	7 13 9.4	36 56 7	0.208	0.487	15.49	0.17
s	AO 0235+164	2 38 38.9	16 37 0	2.79	0.94	15.5	0.96
s	RX J11437+1128	11 43 47.7	11 28 48		0.118	15.5	
s	1WGA						
s	J0827.6+0942	8 27 40.1	9 42 10		0.26	15.5	
s	PG 1352+183	13 54 35.6	18 5 18	0	0.152	15.5	0.08
s	FIRST						
s	J21331+0125	21 33 7.7	1 25 5		0.75	15.51	
s	HS 0727+6205	7 32 18.7	61 59 6		0.325	15.54	
s	Q 0128-2150	1 31 5.5	-21 34 46		1.9	15.57	
s	B2 2201+31A	22 3 14.9	31 45 38	2.806	0.298	15.58	0.27
s	HE 1211-1322	12 13 46.3	-13 38 52		1.125	15.59	0.44
s	PG 1247+268	12 50 5.7	26 31 7	0.001	2.042	15.6	
s	CTS C10.20	21 49 50.0	-44 44 6		1.51	15.6	
s	RXS J00434-1655	0 43 24.8	-16 55 58		0.331	15.6	
s	RXS J01105-1648	1 10 35.1	-16 48 30	0.072	0.78	15.6	
s	HE 0353-3919	3 55 9.9	-39 10 27		1.001	15.6	
s	RXS J04285-1734	4 28 31.0	-17 34 32		0.205	15.6	
s	CSO 409	14 4 38.8	43 27 8	0.001	0.32	15.62	
s	B2 0742+31	7 45 41.6	31 42 56	0.941	0.462	15.63	0.13
s	PG 1206+459	12 8 58.0	45 40 36	0	1.155	15.66	
s	US 645	9 29 9.9	46 44 24		0.24	15.66	
s	HE 2336-5540	23 39 13.3	-55 23 49	0.162	1.354	15.67	

	Name	R.A. (J2000)	Dec. (J2000)	Radio Flux (Jy)	z	Mag_V	B-V
s	B2 1425+26	14 27 35.7	26 32 14	0.131	0.366	15.68	0.2
s	TON 34	10 19 56.6	27 44 2		1.918	15.69	0.37
s	CTS H27.03	3 50 59.3	-52 40 35		1.54	15.7	
s	HE 0210-2809	2 12 32.0	-27 55 4		0.608	15.7	
s	RXS J03552-5451	3 55 13.3	-54 51 57		0.269	15.7	
s	RXS J01353-2923	1 35 20.2	-29 23 57		0.699	15.7	
s	MC 1104+167	11 7 15.1	16 28 3	0.561	0.632	15.7	0.21
s	CTS M16.11	14 16 55.9	-25 24 14		0.236	15.71	0
FIRST	J1306+3915	13 6 13.3	39 15 26		0.447	15.71	
s	3C 249.1	11 4 13.8	76 58 58	0.78	0.313	15.72	-0.02
s	OX 169	21 43 35.5	17 43 49	1.006	0.211	15.73	0.18
s	PG 1407+265	14 9 23.9	26 18 21	0.008	0.945	15.74	0.33
s	PKS 1355-41	13 59 0.2	-41 52 53	1.44	0.313	15.86	-0.1
s	RXS J03003+3855	3 0 20.0	38 54 57		0.19	16.1	
s	B3 0251+393	2 54 42.6	39 31 34	0.404	0.291	16.3	
s	S5 0014+81	0 17 8.1	81 35 7	0.551	3.387	16.3	
s	TEX 2052+239	20 54 29.6	24 7 34	0.138	1.377	16.5	
s	MGB 1853+2344	18 53 28.0	23 44 33	0.163	1.031	16.5	
1SAX J06466-	4415	6 46 37.6	-44 15 33		0.153	16.6	
s	RXS J06112-1922	6 11 17.4	-19 23 0		0.133	16.6	
s	HS 2113+1856	21 15 47.1	19 8 43		0.41	16.6	
s	PKS 1451-375	14 54 27.3	-37 47 33	1.84	0.314	16.69	0.09
s	OT 081	17 51 32.8	9 39 2	2.455	0.32	16.78	0.68
s	TEX 1832+208	18 34 12.2	20 51 40	0.153	1.034	16.8	
s	HS 0704+3835	7 7 56.5	38 30 58		0.4	16.8	
s	HS 2103+1843	21 6 8.5	18 55 50		2.21	16.8	
s	PKS 0858-279	9 0 40.0	-28 8 20	2.216	2.152	17	
s	TEX 2116+203	21 18 34.8	20 34 2	0.182	1.68	17	
s	RXS J02221+5221	2 22 6.0	52 21 12		0.2	17	
s	PKS 1937-101	19 39 57.3	-10 2 41	0.75	3.787	17	
s	TEX 2057+235	21 0 4.9	23 47 3	0.16	1.124	17	
s	PKS 0825-202	8 27 17.4	-20 26 24	1.315	0.822	17	
s	RXS J02276+4410	2 27 39.6	44 9 57		0.175	17.1	
s	HS 0058+4213	1 1 31.3	42 29 36		0.19	17.1	
s	HS 0035+4405	0 37 52.3	44 21 31		2.71	17.1	
s	KUV 06597+3143	7 2 55.0	31 38 39		1.15	17.13	
s	B2 1830+28A	18 32 50.1	28 33 36	0.984	0.594	17.16	-0.25
FIRST	J0729+2524	7 29 28.4	25 24 52		2.303	17.2	
s	MGB 1835+2506	18 35 58.5	25 6 45	0.141	1.973	17.2	
s	PKS 1821+10	18 24 2.8	10 44 24	1.232	1.364	17.27	0.39
s	S2 1848+28	18 50 27.6	28 25 14	0.999	2.56	17.3	
FIRST	J0725+2819	7 25 50.6	28 19 6		2.663	17.37	
s	PKS 1009-321	10 11 56.1	-32 23 37	0.153	1.742	17.4	
s	B2 2310+38	23 12 58.9	38 47 41	0.523	2.181	17.5	
s	PKS 1010-427	10 12 37.8	-42 58 31	0.43	2.954	17.5	
s	PKS 1619-680	16 24 18.4	-68 9 13	1.81	1.354	17.8	
s	4C 39.66	22 20 31.2	39 48 35	0.685	0.655	17.9	

	Name	R.A. (J2000)	Dec. (J2000)	Radio Flux (Jy)	z	Mag_V	B-V
s	1ES 0715-259	7 18 4.9	-26 8 11	0.222	0.465	18	
s	TEX 1908-201	19 11 9.7	-20 6 55	2.053	1.119	18.1	
s	PKS 0743-006	7 45 54.0	-0 44 18	1.31	0.994	18.1	
s	MG J2024+1717	20 24 56.5	17 18 14	0.48	1.05	18.2	
s	4C 46.47	23 13 48.1	47 12 16	0.726	0.742	18.2	
s	TEX 0730-023	7 32 45.1	-2 28 58	0.255	2.75	18.3	
s	PKS 0920-39	9 22 46.4	-39 59 35	1.51	0.591	18.4	
s	3C 185	7 38 33.9	-2 4 24	0.37	1.033	18.4	
s	PKS 1105-680	11 7 12.7	-68 20 51	1.37	0.588	19.2	
s	3C 154.0	6 13 50.2	26 4 36	2.02	0.58	19.3	
s	4C 43.10	3 34 14.3	43 32 23	0.247	0.54	19.6	
s	TEX 0529+483	5 33 15.9	48 22 53	0.589	1.162	19.9	
s	MC 0646-176	6 48 28.5	-17 44 6	1.003	1.232	19.9	
s	MC 0646-176	6 48 28.5	-17 44 6	1.003	1.232	19.9	
f	4U 0241+61	2 44 57.6	62 28 6	0.376	0.045	12.19	-0.04
	FIRST J21398-0804	21 39 51.0	-8 4 54		0.051	13.39	
f	PDS 456	17 28 19.9	-14 15 56	0.008	0.184	14.03	0.66
f	4C 29.45	11 59 31.9	29 14 45	1.461	0.729	14.41	0.39
f	RXS J03383-4510	3 38 23.2	-45 10 48		0.119	14.97	
f	RXS J00018+1116	0 1 50.6	11 16 47		0.158	15.1	
f	B2 1308+32	13 10 28.7	32 20 44	1.497	0.997	15.24	0.37
f	MC4 0031-70	0 34 5.3	-70 25 52	0.095	0.363	15.5	
f	GB6 08168+3143	8 20 0.7	31 34 11	0.023	2.324	15.6	
f	PKS 1216-010	12 18 35.0	-1 19 54	0.28	0.415	15.64	0.53
f	FBS 1229+710	12 31 36.5	70 44 14	0.001	0.208	15.66	
f	1H 0828-706	8 28 17.2	-70 48 59		0.239	16.65	0.41
f	TEX 0716+332	7 19 19.4	33 7 9	0.321	0.779	17.05	0.61
f	J07298+2524	7 29 48.4	25 24 52		2.3	17.22	
f	PKS 0554-026	5 56 52.6	-2 41 5	0.306	0.235	17.4	
f	B2 0704+38	7 7 32.9	38 22 13	0.248	0.579	17.5	
f	MGC J2130+3332	21 30 29.8	33 32 48	0.156	1.473	17.9	
f	TEX 2005+403	20 7 45.0	40 29 48		3.7	1.736	19
f	TEX 1823+107	18 26 25.1	1 49 40	0.943	1.771	19.9	
f	TEX 1823+107 1WGA	18 26 25.1	1 49 40	0.943	1.771	19.9	
g	J0820.1+3728	8 20 7.7	37 28 39		0.082	11.8	
g	3C 305.0 87GB	14 49 21.6	63 16 14	0.92	0.042	13.74	
g	01540+4105	1 57 5.0	41 20 30	0.03	0.081	13.8	
g	F 9	1 23 45.8	-58 48 21		0.046	13.83	0.43
g	MARK 509	20 44 9.7	-10 43 24	0.005	0.035	13.12	0.23
g	MARK 926	23 4 43.5	-8 41 8	0.009	0.047	13.76	0.36
g	NPM1G-22.0017	0 41 32.1	-22 38 38		0.063	13.24	
g	RXS J11401+4115	11 40 3.4	41 15 5		0.071	13.8	
g	RXS J12252+3213	12 25 13.0	32 14 1	0.047	0.059	13	
g	TEX 1601+160	16 3 38.0	15 54 3	0.251	0.109	13.97	
g	WPVS 97	14 55 53.0	-35 48 22		0.035	12	
g	RXS J05345-6016	5 34 31.0	-60 16 15		0.057	14.46	
g	RXS J21158-1041	21 15 51.3	-10 41 22		0.062	14.51	

	Name	R.A. (J2000)	Dec. (J2000)	Radio Flux (Jy)	z	Mag_V	B-V
g	VII Zw 118	7 7 13.1	64 35 59		0.079	14.61	0.68
g	RXS J22481-6803	22 48 9.4	-68 3 14		0.096	14.63	
g	MARK 304	22 17 12.2	14 14 21	0	0.067	14.66	0.36
g	RXS J02541-4137	2 54 7.0	-41 37 31		0.146	14.76	
g	RXS J21240-0021	21 24 1.8	-0 21 58		0.062	14.77	
g	4C 01.13	5 13 51.9	1 56 55	0.131	0.084	14.8	
g	IRAS L06229-6434	6 23 9.1	-64 36 24		0.129	14.8	
g	NPM1G-22.0111	4 44 4.0	-22 24 46		0.076	14.94	
g	PKS 0558-504	5 59 47.4	-50 26 51	0.113	0.137	14.97	0.21
g	RXS J01149-4224	1 14 57.8	-42 24 48		0.124	15	
g	RXS J00569-7513	0 56 55.1	-75 13 52		0.074	15.04	
g	RXS J00340-3354	0 34 1.6	-33 54 22		0.118	15.04	
g	RXS J23008-5545	23 0 52.0	-55 45 45		0.142	15.05	
g	TON S210	1 21 51.6	-28 20 57		0.117	15.19	0.19
g	CSO 900	12 31 56.0	35 30 15		0.131	15.24	
g	MARK 813	14 27 25.0	19 49 52		0.131	15.27	0.15
g	2E 2304-2258	23 7 37.8	-22 43 4		0.193	15.3	
g	PKS 2349-01	23 51 56.1	-1 9 13	0.7	0.174	15.33	0.12
g	RXS J23599+0833	23 59 59.5	8 33 57		0.084	15.4	
g	MARK 876	16 13 57.2	65 43 10	0.002	0.129	15.49	0.54
g	PGC 61965	18 30 23.3	73 13 10		0.123	15.5	
g	MS 21595-5713	22 2 55.4	-56 59 38		0.083	15.5	
g	B3 0225+389	2 28 59.2	39 8 46	0.034	0.336	17.07	
g	B3 0225+389	2 28 59.2	39 8 46	0.034	0.336	17.07	
e	RXS J14183-2111	14 18 19.4	-21 11 12		0.108	14.13	
e	RXS J20593-3147	20 59 20.8	-31 47 35		0.074	14.2	
e	RXS J21079-3754	21 7 59.8	-37 54 9		0.049	14.26	
e	RXS J23529+0320	23 52 58.0	3 20 16		0.086	14.3	
e	7C 1029+2813	10 32 14.1	27 56 0	0.037	0.085	14.3	
e	RXS J10279-0647	10 27 58.7	-6 47 56		0.116	14.35	
e	TON S180	0 57 20.2	-22 22 56		0.062	14.41	0.19
e	RXS J22134-6455	22 13 29.6	-64 55 10		0.071	14.51	
e	NPM1G-13.0021	0 30 40.2	-13 21 29		0.076	14.56	
e	RXS J05363-5144	5 36 21.3	-51 44 8		0.113	14.69	
e	FBS 0732+396	7 36 23.2	39 26 17		0.118	14.7	
e	1WGA J2153.3-1513	21 53 19.1	-15 14 12		0.078	14.7	
e	HE 1106-2321	11 8 53.1	-23 38 11		0.081	14.82	0.59
e	MS 15198-0633	15 22 28.8	-6 44 41	0.006	0.084	14.9	0.3
e	Q 0043-2923	0 45 48.1	-29 6 57		*0.90	14.9	
e	RXS J11357-0937	11 35 46.2	-9 37 58		0.102	14.91	
e	MARK 1320	12 19 8.8	-1 48 29		0.103	15	
e	RXS J13232+4631	13 23 14.9	46 31 21		0.143	15	
e	RXS J00103-0617	0 10 20.0	-6 17 6		0.078	15.01	
e	RXS J16212+1819	16 21 14.4	18 19 50		0.125	15.2	
e	KUG 1226+285	12 28 30.9	28 14 12		0.1	15.3	
e	IRAS 01475+3554	1 50 32.7	36 9 26		0.08	15.3	
e	2RE J2248-510	22 48 41.2	-51 9 54		0.102	15.43	0.17
e	PHL 2525	0 0 24.4	-12 45 48		0.2	15.49	

	Name	R.A. (J2000)	Dec. (J2000)	Radio Flux (Jy)	z	Mag_V	B-V
e	RXS J12231+4744	12 23 11.5	47 44 27		0.163	15.5	
e	HE 1127-1924	11 29 30.4	-19 41 1		0.918	15.62	
e	PKS 0837-12	8 39 50.6	-12 14 34	0.76	0.198	15.76	0.02
e	PKS 0736+01	7 39 18.0	1 37 4	1.92	0.191	16.47	0.43
e	2EG J0852-1237	8 50 9.6	-12 13 34	0.834	0.566	16.8	
e	PKS 1116-46	11 18 26.9	-46 34 15	1.31	0.713	17	0.3
e	PKS 0812+02	8 15 23.0	1 54 58	0.845	0.402	17.1	0.18
e	TEX 1825+344	18 27 0.0	34 31 14	0.331	1.814	17.4	
e	OH-010	6 7 59.7	- 8 34 49	2.73	0.872	17.6	
e	3C 395	19 2 55.9	31 59 42	1.81	0.635	17.6	
e	4C 49.48	23 58 9.9	49 21 44	0.399	1.052	18	

The first column is my optical type ID:

s = (almost) stellar appearance = "good"

f = faint on red POSS, else o.k.= "likely o.k."

g = circular symmetric structure (galaxy) = "maybe o.k."

e = slightly elongated, compact elliptical= "mabye o.k."